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SIGMA XI QUARTERLY

EDITORIAL COMMITTEE

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THE COLUMBUS CONVENTION

The regular annual Convention of the Society of the Sigma Xi will be held in Columbus, Ohio, on Tuesday, December 28, 1915. Delegates will assemble in Page Hall at 4:00 p. m. for the business session at which appropriate and legal business will be transacted as provided in the Constitution. The annual dinner will be served at 6:30 the same evening in the Ohio Union. All members of the Society will be welcomed at the dinner which is informal. Official notices regarding the Society and the Convention will be posted at the Headquarters of the American Association for the Advancement of Science and communications for the officers of the Society may be sent in care of the Association. Reservations for the Sigma Xi dinner should be made as early as possible and lists will be left for signature at the Headquarters. Places may also be reserved by mail in case members do not plan to arrive until late.

It is important that every chapter take account of its privileges and duties in connection with the annual Convention. The new Constitution lays upon this Convention greater responsibilities and also far greater powers than any has ever enjoyed before. Charters are granted by a three-fourths vote of the convention. Honorary members may be chosen by a three-fourths vote of the delegates present at any convention. Officers shall be elected at conventions. This year the only election—save in the event of vacancy occurring by death or resignation—is that of a member of the Executive Committee to serve five years. The convention has power to lay assessments on chapters, approve or disapprove by-laws formulated by

chapters, amend the Constitution subject only to the condition that the amendment was proposed at the previous Convention. Several amendments are pending this year, having been proposed at the Philadelphia Convention and laid over under this rule. These were printed in the QUARTERLY for March, 1915, pages 8 and 9.

In the past the Society has suffered because some chapters were too careless or indifferent to appoint delegates and under the old rule which required representation of three-fourths of the chapters to make a quorum it often happened that those delegates who had come at some sacrifice of time and other duties found themselves powerless to enact any legislation. This condition has been changed. The new Constitution provides in Article VIII, Section 3.

QUORUM—The delegates from the chapters in good standing in the Society, present at a duly called meeting, shall constitute a quorum at a convention.

Consequently if your chapter does not name any delegates, it will have no share in deciding the important matters sure to come up for consideration at the meeting. Chapters should notice the provision that its delegates vote as a unit on most questions and that they may be "resident or non-resident members." Indeed "in case any chapter shall be unable to send its own members, it may appoint members of any other chapter as its representatives." Those chapters which send delegates well versed in the history of the Society and vigorous in defense of its highest ideals will do much to spread their influence and further its development. Those chapters which ignore or neglect the privilege will merely deprive themselves of a part in shaping its history.

OPPORTUNITIES AND RESPONSIBILITIES OF SIGMA XI

Since the founding of Sigma Xi nearly thirty years ago, there have been great changes in the scientific world. Then, the rewards of the investigator were few. His own innate curiosity together with the personal satisfaction which he felt in having sought for and found "the truth" spurred him on to further search. Then came Sigma Xi, which gave him some tangible, if not pecuniary recognition. The Society performed a great service.

But how different are conditions today! The whole world recognizes its debt to the scientist. The young college graduate in science

need no longer look forward to teaching as the only profession open to him. The industrial world awaits his coming. His rewards are many.

Under these changed conditions, new opportunities and responsibilities loom up before Sigma Xi. Our first duty should be to recognize what those responsibilities are, and then having found our problems, we should take steps to extend our activities commensurate with our enlarged duties and opportunities.

The article in this number on Sigma Xi and Industrial Research by Dr. H. E. Ives indicates to us in a very forceful manner, one of the directions in which Sigma Xi can be of increased usefulness.

F. K. R.

A Uniform Stationery

The growth and development of Sigma Xi has resulted in increased correspondence between the various chapter and society officers, and with the general public. There are various reasons why, in this correspondence, an official and distinctive stationery would prove advantageous. If a sufficient number of chapters were to indicate a desire to coöperate in this matter, arrangements could doubtless be made to provide such supplies through some dealer at a reasonable cost.

SIGMA XI AND INDUSTRIAL RESEARCH*

HERBERT E. IVES, PH.D.

The Society of Sigma Xi stands today in an anomalous position. Its avowed purpose is ambitious; its machinery quite inadequate for that purpose. The function of Sigma Xi is the encouragement of scientific research, but scientific research is no longer monopolized by those academic centers about which the Society was built. The extraordinary development of industrial research, both in quantity and in scientific quality, threatens to leave the sponsor of "zealous research" in the perplexed condition of a motherly hen whose finest and largest eggs hatch into creatures that fulfill their destiny on aqueous stretches not approved by their foster mother. Shall the industrial reasearch ducks be considered as proper material for society activity, with a consequent revision of the society organization, or shall Sigma Xi be content with its original but now restricted field, namely, scientific research in universities?

The necessity for facing new problems, while frequently a nuisance, is the best evidence that growth and development are taking place. In large measure Sigma Xi may take to itself credit for the spread of the ideals of scientific research in this country; consequently the existence of the problem under discussion may be viewed with some complacency. Quite otherwise would it be if the Society were being brought to task for failure, rather than for signal success.

For a proper understanding of the Society's problem, it is desirable to trace the metamorphosis of research in this country since the time of the inception of Sigma Xi. Who then carried on research and why? Who carries it on now and why? Research has been at one time and another the hobby of the scientific amateur who dabbled in it for the gratification of his esthetic or religious sense; the voluntary or required part-time activity of the scientific teacher who must fill in gaps in the body of knowledge he must teach; the continuous and unique occupation of professional researchers employed in research organizations supported either for commercial or philanthropic purposes. Still another class of scientific investigators who have been of enormous influence in this country, cannot be overlooked—the inventors, those one-man research organizations.

*Contributed by invitation.

At the time of the founding of Sigma Xi, scientific research in America was chiefly carried on by two of these groups: the scientific teachers in the universities, and the inventors. Broadly speaking the inventor, in spite of the glory and service he contributes to the country, does not seem to have been thought of as a scientific man at all. In those days he was rarely a university man; he was not a gentleman of leisure; he had to make a living out of his special ability, and was in consequence undoubtedly looked down upon as a selfish money-grabber by many of the teaching group who had exalted ideas of the spiritual quality of pure science. At any rate, Sigma Xi, founded to encourage scientific research, was and still is primarily a university institution.

In the last thirty years a process of shifting and readjustment has taken place. There has been least change in the universities. Research is still considered the legitimate part-time work of the teacher. .But with the extreme specialization which has gone on in all science, comes the danger that the really active research man may lose that breadth of view which is more than necessary for the teacher who is responsible for laying the foundation of knowledge. Add to this the competition of the professional research man in supplying the very knowledge the teacher needs and once had to seek for himself, and it is easy to understand its being asked here and there whether research should be expected to the extent it has been from the professional teacher. Research in the universities, to put it conservatively, has not the encouragement to grow that it has in certain other quarters.

Meanwhile the individual inventor has been to a large extent swallowed up by the advances in industrial organization. He is no longer under the necessity of working alone with inadequate facilities; moreover, his opportunity as a free-lance is narrowed. There are fewer chances now for happy accidents. The fields have been plowed over pretty thoroughly. Today he is apt to be a member of the development or research department of a large company.

Here he meets the university man who is a research specialist but has not stayed in the university. Together they make up the industrial group, which in numbers and in the quality of the work turned out, does or soon will exceed all the others in research work, at least in the physical sciences. They are men devoted to the scientific method, doing work of permanent scientific value, keenly interested

in the advancement of science, and valuable public servants. Who would seriously question their equal right to be "zealous companions in research" with the teacher of science?

There has existed a general impression that there is a definite line of demarcation between pure scientific research and industrial research, whereby one is scientific and the other merely commercial—that scientific research has no practical end in view, and that industrial research is solely for practical ends. This differentiation, were it true, has been supposed to carry with it a reproach upon things practical. Such a viewpoint, a relic of days when science was the monopoly of the "gentleman" who looked askance at the "shopkeeper," is surely out of place in the country which produced Franklin and Edison; out of place especially at a time when conservation of our natural resources—achieved only by science—is recognized as a paramount, material, and social task. But it is only necessary to study the more recent research work of some of the larger industrial laboratories of the country to learn that this distinction is very far from true. Much of the very best theoretical and apparently impractical work of recent years has come from them.

A nearer approach to a true distinction is arrived at by starting with the premise that research work is only undertaken if it promises to be a good investment. This applies equally to the investigator who is prompted by curiosity and sticks to it for the intellectual gratification he reaps, to the teacher who gets out knowledge of use to him in his profession, and to the industrial organization which increases its dividends.

The difference then between industrial and other research is that industrial research is that kind which is a good investment to an industrial organization. It need not differ at all either in subject matter or in relative attention to theory and practical details from a research in a university, or in a philanthropically endowed institution for public service. It is all a question of the decision of those responsible for the policy of the research laboratory as to where to draw the line between what is a good investment and a bad one. Thus it might be an excellent investment for a commercial laboratory to assign a man for five or six years to the study of a point of theory whose elucidation would facilitate its work, whereas a graduate student in a university, hoping to be through in three years, would consider the same problem, theoretical though it were, as a poor

investment for him. The time is actually here in some branches of science when the development of purely theoretical work (in the narrow sense of the word theoretical) is recognized as a proper investment for the industrial laboratory, and it is surely coming in other branches. Certain phases of theoretical work will, of course, always be practically restricted to the university, and rightly so, but it is of importance to recognize that the university has no monopoly thereby.

It is because research is proving a good industrial investment that the industrial laboratory now offers attractions in the way of facilities and opportunities for work and for public service that seriously compete with the university. How good an investment is, is considered as illustrated by the expenditure of some of the big companies. Thus it is reported that our chief telephone company spends annually on research more than the entire budget of some of our large universities. The chief electrical, oil, steel, and public utility companies spend some hundreds of thousands annually for this purpose. Their laboratories rival those of the government and the foremost universities in facilities and equipment.

The debt of these organizations to the universities for ideals, methods, and men is tremendous. But what must now be recognized is that the university research laboratory has things to learn from industrial research. A characteristic of industrial research of the present day is its definiteness of aim and thoroughness of execution. A whole corps of investigators may be employed on a problem of importance, the attack upon which can be planned like a campaign and carried through to a definite conclusion, even though it takes years and though the personnel of the workers be changed.

A real distinction between much university research and industrial research lies, of course, in the fact that industrial research is definitely aimed toward the solution of problems of practical value to humanity. Much has been written about "science for science's sake," and slurs have been cast on the aims of those who apply science to the improvement of manufacturing processes, or to the amelioration of the material condition of the human race. As a matter of fact it is probable that very few men do research work without the hope and belief that they are thereby contributing to the ultimate material welfare of mankind—let us hope so at any rate. The development of applied science has done more in the last few decades to uplift the whole of mankind and set it free than

have all the other forces at work in the world. A recent writer on the value of scientific work puts it thus:

"It is the only occupation worthy of a man who desires to benefit the world as much as possible by his residence in it." If this be granted, then industrial research can make this claim to merit; that it studies more intelligently the really important problems and attacks them in a more efficient manner than is often done in the universities. The latter are frequently too open to the criticism that they have not kept in touch with the changing needs of industry. Thereby they miss many valuable points of view; their perspective is distorted; they overlook lines of work that are opened up by large scale engineering developments which frequently illuminate in a way that small scale laboratory work cannot. Measurements and studies are often painstakingly made by university laboratories on quantities or methods long since discarded or superseded by the wider angle vision of the laboratory in touch with industrial conditions. In fact it is not too much to say that much university research looks to men in the industrial field as amateurish and poorly aimed.

One more aspect of industrial research may be dwelt upon before the direct bearing of all this on Sigma Xi is considered. Some capital has been made for research in our educational institutions on the ground that their work is not done for selfish ends, but is freely given to the world. As a matter of fact this is a question practically always settled by the individual investigator, though it may claim to be an ideal sometimes adhered to. But this claim of university research to be on a higher moral and social plane than private or industrial work explodes very quickly when considered not as an abstract proposition of good intentions, but in the light of practical conditions. Actually in the vast majority of cases the only way to give anything to the public is through the industries. In the first place the public is almost always ignorant and indifferent. Daguerre for years could interest no one in the photographic process, and more recently the telephone and the half-tone engraving process went begging. It is a characteristic of the inventor to know the value of his work better than anyone else. And it is a blessed dispensation that he usually is endowed with faith and enthusiasm to push and struggle until the public swallows the medicine. In the majority of cases it is quite safe to say that the inventor is far more interested in the success and adoption of his device or

process than in the financial return. The exploitation and development of a new industrial process or machine demands capital. Capital cannot be obtained without the kind of protection that is most wisely intended in our patent laws. No sane manufacturer is likely to bear all the cost of development of an idea if anyone may step in and take advantage of his work at no cost, because that idea has been freely given to the public. Now one of the ideals of research (and of Sigma Xi) is that of service. In many lines of work the real opportunities for an investigator to render real service lie in his attaching himself to an industrial organization which shall be interested and equipped to get his ideas to the public in useful form. In point of actual service rendered to society, the industrial research worker can make today quite as good a claim to recognition as any other worker. Any serious attempt to deny his claim partakes of the nature of snobbery.

The foregoing characterization of industrial research is intended to illustrate how fully are the ideals of Sigma Xi exemplified by it. What, if anything, is Sigma Xi called upon to do?

The relationship of Sigma Xi to industrial research is to be practically determined by the amount of activity and influence the Society feels impelled to exert. It has several alternatives: It might endeavor so to expand its scope as to be a national research society, including in its active membership all men prominently active in research no matter where carried out. What might be the useful function of such a Society? It might definitely restrict its activities to the encouragement of research work in the universities. Is this a valuable activity? Or it might content itself with what has sometimes been its chief function in the past: to offer a purely honorary distinction to the undergraduate who does good work in the sciences, as distinguished from the classics. What can be said for this?

There does exist a field for a national society of research workers. We need in this country unusual aids to what has been termed the cross fertilization of the sciences. Unlike the "tight little isle" which has been the source of such wonderful scientific activity in the past few generations, our scientific institutions and men cannot gravitate to one geographical center. They must be kept informed of each other's work and ideals by artificial means of transportation and communication. Our scientific activities are widespread and specialized. We increasingly need machinery to keep the university man in touch with the industrial man, to keep man, distant from

scientific centers, informed of their work. In each branch of science this need is largely taken care of by the journals of the various scientific societies. But the very important matter of the meaning and aims of scientific research as a whole does not fall within the field of these. There is a real danger in the development of scientific research that the workers will lose, in their specialization, the basic ideas of all sciences. It is an all too common experience to find clever technical men who have no mature ideas outside their own line of work, who appear never to have given a thought to the relation of their work to general scientific principles, or to the general relationship of scientific work to society. It must be sadly admitted too that the training in love of truth which it is the proud claim of science to impart does not always mean that the scientist shall be able to distinguish truth from falsehood in his other human relations. He may be as bad a dupe as the most unscientific when questions of world politics arise. The scientific man needs his philosophy and code of ethics, and there is serious question whether any adequate steps are now taken to help him to them. Sigma Xi might consider assuming as its field the encouragement of mutual acquaintance between scientists in different lines of work but of similar ideals. It might take as its special charge the discussion of these ideals and propaganda for greater attention thereto in the institutions of instruction. A more general recognition of the ultimate aims of science among scientific men themselves—it may with propriety be called more religion—would be a worthy object for a society to strive to promote. The resulting higher standing of scientific work with the public could then be left to take care of itself.

In this connection the writer may be permitted perhaps to remark that such a function could be most practically carried out by a widely circulated journal containing matter calculated to give information on the advance of science of all kinds, interspersed with some philosophy. Such a periodical is *The Scientific Monthly* (formerly *The Popular Science Monthly*). Is the suggestion out of place that such an extension of the Society's activities as just discussed might include the adoption of that journal as the official publication?

The undertaking of such a program—a logical step if the original ideals of the Society as stated are to be adhered to—would, of course, necessitate a revision of the manner of making elections and the customs with respect to chapter and meeting centers. Such

would not be the case with the other alternatives which have been hinted. These may be considered together. Should Sigma Xi be content to be a purely university organization, either as a research society, or as a scientific honor society? From the standpoint that the university is the feeder to the community at large, the fostering of the ideals of research in those who pass through its classrooms is every bit on a par with every other educational influence. It constitutes a legitimate and honorable activity for a society. But to be honest with the world no false implication should be allowed to stand, that research is solely a university specialty, or on a different plane from the research the student is more than apt to engage in after he leaves.

As to Sigma Xi contenting itself with being solely the scientific Phi Beta Kappa, even this is a field not at all unworthy of maintaining. Much may be said with justice against honors and awards for scientific work. They are often, in the nature of things, given by bodies far less fitted to judge of the value of the recipient's (or non-recipient's) work, than he is himself, as a specialist. If the pioneer depended upon his contemporaries' opinions for inspiration or were not ready to continue despite their adverse judgment, he would cease to be a pioneer. Fame and reward drift to a large extent toward those branches of science which are popular, and the social personality of the man chosen for distinction is something of a factor. Now, the point of this comment is that in the award of the Sigma Xi key the student meets probably for the last time a judgment of his capacity by competent judges secured under even sporting conditions. The consequent inspiration and consolation later when conditions are changed may often be a very potent factor in holding him to his path. There is no need to conclude, as some have done, that the Society is useless if its function is restricted to this.

The growth of industrial research may be interpreted as calling for a great extension of the activities of Sigma Xi. A useful field is open for a society which shall knit together all the research activities of the country. At the same time the usefulness of a society frankly restricting itself to the universities is immense. Opinions will differ as to whether there is any call for an extension of these activities. Should not the Society, however, set its house in order? Should it not either expand into the whole research field which it originally claimed as its own, or more strictly define the narrowed boundaries which are, with its present organization, left to it?

THE GOALS OF SCIENTIFIC RESEARCH

PRESIDENT'S ADDRESS READ BEFORE THE CORNELL CHAPTER OF THE SIGMA XI, MAY 17, 1915.

A. W. BROWNE

Members and Members-elect of the Society of the Sigma Xi; Ladies and Gentlemen:

We are assembled tonight in order that our older members may welcome in the manner prescribed by the Constitution those who in recognition of their achievements, actual or potential, in scientific work have just been elected to membership in our Society; in order to do honor to those whom we shall henceforth be proud to designate as our fellow members in the Society of the Sigma Xi—as our Companions in Zealous Research.

Before we proceed with the simple ceremony provided by the Constitution for the initiation of new members, it is the duty of the President to explain to the initiates the aims and objects of the Society. This requirement I shall endeavor to fulfill, after amplifying somewhat the rather terse statement of our aims and objects contained in the Constitution, by briefly outlining what in my judgment should constitute the chief *Goals of Scientific Research.*

From its foundation our Society has aimed to foster the true spirit of scientific research. Its object, as summarized in Article I, Section 2 of the Constitution is "to encourage original investigation in science, pure and applied, by meeting for the discussion of scientific subjects; by the publication of such scientific matter as may be deemed desirable; by establishing fraternal relations among investigators in the scientific centers; and by granting the privilege of membership to such students as have, during their college course, given special promise of future achievement." This statement may fairly be construed to imply that our function as Companions in Zealous Research is of a threefold character—investigative, social, and pedagogic.

Our first duty as members of Sigma Xi is to respond to the demand made upon us for productive scholarship. Our Society has always exercised a potent though largely unrecognized influence in upholding the idea that in University circles the teacher of science should be not merely a distributor or disseminator, but also a producer or discoverer of the truth. The successful teacher of science,

pure or applied, must be held in his orbit by the combined action of the centripetal force of thorough scholarship and the centrifugal force of original research.

In the second place, it should be our aim to effect, through the medium of our meetings both formal and informal, and through the medium of our personal friendships, the closest possible coördination among the numerous scientific interests represented by our members. The very diversity of these interests should insure, once they are brought into appropriate relations with each other, a solidarity of organization that should lead to a clearer and wider vision of the truth for each of us.

A third responsibility, which rests especially upon those of us who are teachers, is that of participating not merely in the work of scientific investigation but also in the work of training scientific investigators. It would be difficult to overestimate the importance of this latter process. If we consider that the two great functions of the University are those of teaching and investigation, using the term investigation now to include productive scholarship in all departments of work, then in training investigators or productive scholars we are in effect bringing these two functions into simultaneous exercise. The armed forces of the University march into the Land of Ignorance, into the Territory of the Unknown, on two main lines of advance: the line of pedagogy, and the line of research. The intersection of these two roads is undoubtedly one of the most important strategic points along the entire front.

Or, changing the figure, and looking upon the University as a great manufacturing plant, we find its two chief products to be: men, and research. Now when the University succeeds in training a man capable of following the career of the true scientific investigator, a third product, which virtually combines the characteristics of the other two, is obtained. And possibly it may not be going too far to suggest that the trained investigator is, in a sense, the *main* product of the various scientific activities of the University, while research itself, however important and useful, partakes more of the nature of a necessary by-product. In view of the importance of the process of training men in research, which I think none will deny, it is a source of gratification to find that our Society makes provision for the recognition of undergraduates who have passed through the first stages of their training as investigators, and who have "given special promise of future achievement."

Let us now turn to the topic chosen for our brief consideration this evening: *The Goals of Scientific Research.* It is not my purpose to discuss the various motives that should or should not actuate the individual scientist—that should or should not serve as the inspiration of his work. Nor shall I speak of the nature, scope, or method of research. These topics have been ably disposed of by several of my distinguished predecessors in their Presidential addresses during the past few years. I would simply raise the question: Whither does Science lead us? To those engaged in the pursuit of science this question both in its individual and in its larger social aspect should be of considerable interest.

Perhaps the most conspicuous, and certainly in the popular mind the most important goal of Science and of Scientific Research is *the increase in the control exercised by man over his material environment.* "But," you say, "this spells Applied Science!" Yes, I even venture so far as to say that one of the very important functions of science is to supply inspiration to industry. Pure science, until it is incarnated in industry, is but little met with in the ordinary walks of life; while industry, until it has been enlivened by something of the spirit of pure science, is sordidly empirical. This mutual relationship—or symbiosis, as it might be called—between science and industry has reached under present conditions so advanced a stage of development that scientific investigators working in the large research laboratories of industrial corporations not infrequently make discoveries of great value to pure science. A notable instance of this sort occurred quite recently in the Research Laboratory of the General Electrical Company at Schenectady, where Doctor Langmuir in the course of his investigations upon the tungsten lamp discovered an active modification of hydrogen. Thus industry sometimes pays dividends on investments of pure science in currency that is legal tender even in scientific circles!

Instances of this sort might be multiplied. There is certainly no inherent reason for the antagonism that has appeared at times to exist between pure science and industry. There is no need for the mutual distrust with which each has now and then regarded the other. When haughty science, peering out into the world from her cloistered retreat, shall come to realize that there is need for something of her idealism in ordinary life, and when her more matter-of-fact sister, industry, learns to bow reverently with her at the inner shrine of truth, then shall true harmony be established. The

main reason for discord in the past has been, in my opinion, the comparative lack, in the ranks of industry, of men thoroughly imbued with the scientific spirit, and willing to make personal sacrifices in order to extend the kingdom of truth. The question might well be referred to our own Society, which, as we have heard, aims "to encourage original investigation in science, pure and applied," and which should aim more and more to encourage the training of men for research in the fields of science and industry alike.

Yet it is not to be inferred that the relationship between science and industry is so close that the scientific investigator should, as a rule, have in mind some possible application of his work. This would indeed be a short-sighted policy! For the history of science is replete with instances in which purely scientific discoveries have led to entirely unexpected practical applications.

But science does not merely offer to man the increased control over his material environment obtained through industry. It offers that which is of vastly greater import to his inner life—an ever-widening mental horizon. A second goal of science and scientific research is therefore *the bestowal upon man of a broader vision of the truth,* of a clearer and more accurate world-picture. Let us now briefly review in outline a few of the steps of progress made in this direction.

In the first place our conception of the magnitude of the universe—of its extent in space—has been greatly enlarged[1]. In 1543, Copernicus, by giving the death-blow to the Ptolemaic system of astronomy, with its geocentric conception of the universe, helped to prepare the way for the work of our modern astronomers whose colossal telescopes enable our vision to penetrate into regions of the universe inconceivably remote.

Secondly, our conception of the duration of the Universe—of its extent in time—has been wonderfully magnified. Thanks to the researches of geologist, paleontologist, and archeologist, alike, no scientist of the present day believes that the Universe was set in operation by special creative fiat six thousand years ago, as maintained by tradition. The great antiquity of the earth and of man himself, has been well established.

And yet, strangely enough, even while we are contemplating the great extension of our Universe in space and in time, and are try-

[1] See *Christian Faith in an Age of Science* by William North Rice, pages 15 et seq. A. G. Armstrong and Son (New York).

ing to grasp the full significance of these two concepts, the thought comes to mind that science during the last few decades has been planning a surprise for us. Yes, in spite of her efforts to present to us the loftiest view of space and time she seems to have entered into a conspiracy with invention and industry to free us, so far as possible, from their limitations. It is surely obvious that the introduction of speedier methods of transportation virtually enables us to conquer, to a certain extent, both space and time. And so with the means for bringing into close auditory communication persons in widely separated localities; for perpetuating fleeting vocal impressions and permitting their frequent repetiton long after the cords that produced them have been forever silenced; for reproducing visually at will complex series of motions, allowing the crystal to form, or the rose-bud to blossom in the thousandth part of its normal period;—all of these processes involving the use respectively, of railroad, steamship, aëroplane, telephone, phonograph, and kinetograph, those marvels of recent years—strike from our hands, in a sense, the shackles of space and time. And does this not lead us in our moments of vision, to wonder whether science is not—all unconsciously, perhaps—moving in such a direction as to bring so far as possible Man's material environment—his outer world—into harmonious relationship with his mental environment, that inner, metaphysical world in which space and time are said to be unknown, and in which location is determined by state of mind, and time is replaced by the inevitable sequence of cause and effect? Is not science—again unconsciously—striving to express on a large scale for the race that which corresponds with the law of psychophysical parallelism for the individual? It was Thoreau who asked the question:

> "What sort of space is that which separates a man from his fellows and makes him solitary? I have found that no exertion of legs can bring two minds much nearer to one another."

But we must not digress. You have probably suspected by this time, that the second goal toward which I believe science is tending to progress might be named with the single word *philosophy*.

The desire to attempt the formulation of a world-picture of some sort seems to be inherent in the thoughtful human mind. Among the ancient Greeks the existence of a certain similarity or analogy between the universe as a whole and the individual man was

accepted as a commonplace from the time of the earliest awakening of speculative thought. Allusion to this analogy between the macrocosm and the microcosm,* as it later came to be termed, is to be found in the writings of Heraclitus, Empedocles, Plato, and Aristotle, of the Stoics and the Schoolmen as well as in the works of many mediæval and modern thinkers. In the monadology of Leibnitz, for example, the monad, or individual human soul, is deemed to contain within itself an expression of the entire universe.

Turning again to modern science, we find what at once impresses us as being, at the very least, an interesting coincidence and perhaps something much deeper. In biological science it has long been recognized that there is a certain similarity between the order of development of the individual and that of the group, or as it is usually phrased, a *parallelism between ontogeny and philogeny*. This principle admits of numerous applications. Emerson, for example, in his essay on history has called attention to the analogy between biography and history—between the life of the human individual and that of the human race. And much ink has recently been consumed by our peace propagandists in the effort to convince the nations of the earth that they should behave toward one another after the fashion of gentlemen, or better still, in the manner of various organs harmoniously working together in one great social body.

And not only in biological but also in physical science do we obtain some evidence of the analogy between the Great and the Small. With the adoption of J. J. Thomson's corpuscular theory of matter we are able to dispense with our older notions concerning the nature of the atom which we now regard as a system of concentric rings of negatively charged corpuscles rotating with an almost incredible velocity about a sphere of positive electrification. As sketched by one authority the atom takes on something of the appearance of the planet Saturn, or it may be regarded as analogous in a certain sense, with the solar system or even with the still greater stellar systems.

Of much deeper significance than this rather superficial analogy between solar system and atom, however, is the parallelism that may be observed *between the order of development of the universe and that of our knowledge of the universe.* It is well known that the story of cosmic evolution as ordinarily told begins with a chapter

*See *Encyclopedia Britannica*, 11th Ed., Vol. 18, page 381.

on *astronomical evolution*. As the result of this process occurred the individualization of the great masses of matter composing the planets comprised in the Solar System, including, of course, our own earth. Then followed an epoch of *physical evolution* during which important molecular changes, such as those attendant upon a general lowering of the temperature, took place. After the temperature of the earth had fallen to a certain point, the atoms of the various elements were able to give up, to some extent, the mad dancing into which they had been driven by the heat, and to settle down in obedience to the dictates of chemical affinity, in the form of staid and stable chemical compounds. During this period of *chemical evolution* progress toward ultimate chemical equilibrium was made, with the aid of innumerable chemical reactions.

And finally, after conditions had become suitably adjusted, Life appeared, and the long era of *biological evolution* had begun. This process has taken place in several stages, including those of *botanical and zoölogical, physiological, psychological, and sociological evolution.*

Comparing now this cosmic order with the order of the development of the sciences in the mind of man, we find that it is very much the same. If the degree to which the facts and principles of a given science may be accorded precise mathematical expression be accepted as the criterion of the completeness of that science, then it will be recognized at once that astronomy is the most nearly complete science, and that physics, chemistry, and biology follow in the order mentioned. It would seem that both in the great Cosmic Mind, as it finds expression in Nature, and in the mind of man, the various types of material aggregate are brought into equilibrium in this order: first, masses; second, molecules; and third, atoms.

A tendency to follow this same order is moreover to be observed in various other departments of activity. As a means of effecting transportation, for example, animal power has long since given way to steam, and this in turn has to a considerable extent yielded to gasoline. Now in the first instance the forces developed are merely mechanical, involving the motion of masses of matter; in the case of the steam engine the expanding molecules of steam do the work; while in the internal combustion engine the force is developed through atomic activity.

In the development of various devices for hurling projectiles upon his enemies, man has also followed the usual cosmic order. After tiring of the primitive method of hurling stones and other missiles with the mechanical force of his unaided hand, he invented the bow, the elasticity of which depends upon molecular properties; and, later on, gunpowder, the explosive force of which is developed as the result of atomic transformations.

Now while I do not pretend that these various statements offer any proof of the validity of the parallelism between macrocosm and microcosm, I would at least say that taken together, they do curiously tend to confirm the intuitive wisdom invoked by the ancients in their attempt to formulate a world-picture. And one lesson that we can learn from them is that concerning the value of analogy—kept, of course, within its proper limits—as an aid in the attainment of a broader view of the universe.

As scientific investigators we are perhaps entitled to consider ourselves as in some way related to the eye of human society. If, however, the investigators in each department of research are able to see only that which directly pertains to their own narrow interests, and do not aspire to gain some vision, however faint, of the entire universe, this eye of society is to be likened to the compound or mosaic eye of certain lower animals, with its numerous, more or less independent elements, rather than to the human eye. As the scientific investigator is led in the direction of philosophy, which we are considering this evening as the second goal of research, he gradually loses the character of a mere ommatidium, and begins to contribute, for the benefit of the race, his tiny share toward the formation of a true cosmic image. As we progress toward this goal we find that again we are in a sense rising superior to both space and time in that we are entering into affiliation with kindred minds that live, or have lived, in all places and in all ages. And not only must we at times listen to voices of the past, but also, as it were, to those of the future. With the aid of our power of scientific imagination we should make every reasonable effort to anticipate future progress, for only by so doing can we hope to produce, in our minds, a reasonably complete picture of Science as a coherent, consistent whole.

For each of us must admit, with Tennyson* that

. . . . . men through novel spheres of thought
Still moving after truth long sought
Will learn new things when I am not.

And finally there is a third goal, toward which, in my opinion, scientific research tends to lead us:—*the attainment of culture.*

Now the term culture has been variously defined, and undoubtedly access to that for which it stands is to be gained by various means. I somehow feel, however, that the character of our desires, our tastes, our affections, and our ideals has more to do with our cultural status than has the character of our thoughts and actions, important as this may be. Unless our work as scientific investigators leads us to a genuine *love of the truth* that becomes more and more akin with the passing years to a ruling passion, to the exclusion of our sordid desires for honor, fame, or wealth, we shall not have received the highest gift that it is in the power of science to bestow.

Let us then, members of Sigma Xi, do our utmost as opportunity may be accorded to us, to aid in the progress of Science toward these three goals—Industry, Philosophy, and Culture.

*"The Two Voices," *Poetical Works* (Students' Edition), page 33.

IMPRESSIONS*

E. C. Mayer

After having read the very able and interesting article entitled, "Taking Inventory," which appeared in the QUARTERLY about a year ago, it occurs to the writer that possibly some further attention may be devoted to a consideration of an unfortunate condition which at present exists within the Society.

It appears that in order to obtain data relative to the status of Sigma Xi, and of more or less general interest, the former Recording Secretary of the Cornell Chapter sent a circular letter to all the chapter secretaries, in which letter, among other questions were the following: "What means, if any, are being taken in your chapter to keep in touch with your nonresident members, particularly those who have no opportunity to affiliate with other chapters? Has your chapter ever considered the question?"

By far the majority of the replies indicated that no means at all were being taken to get into contact with the alumni membership, in fact, that the question had never been considered. Referring to the statistics as given in this article, one finds that some five thousand alumni, constituting approximately eighty three per cent of the total alumni membership, are beyond any direct influence of the Society. It is reasonable to believe that this entire number never receives any official notices whatsoever from their respective chapters. And yet, notwithstanding the fact, most of these members are engaged in research in the pure and applied domains of science either in educational institutions, or in the larger commercial enterprises.

No immediate statistics are available, but nevertheless it seems plausible to assert that ninety per cent of the total alumni membership consists of those who have been elected to active membership as seniors in the last year of undergraduate work, and thereafter become alumni members upon severing connection with their respective institutions. In the majority of chapters, the date of election of new members is put as late in the collegiate year as practicable; not a few chapters arranging the election some time after the first of May. This procedure undoubtedly does have its advantage in that it permits a reasonable time in which each prospective candidate may establish his promise of ability or else

*F. K. Richtmyer, SIGMA XI QUARTERLY, December, 1914, pp. 91-104.

undertake to a fair degree of completion some problem of research which may be justly considered as such. The result is that the newly elected seniors, who on the whole generally constitute between forty-five and fifty per cent of the elected members, are initiated into the Society so late in the year, that opportunity is available to attend but a single meeting. Commencement follows soon after, and as a result, the larger percentage of these neophytes leave for callings where they are generally never discovered by the Society. Indeed an altogether too short time exists before the college graduation in which a senior may have opportunity to become acquainted with the Society, its history, importance, and ideals. It has come to the writer's attention that some alumni have even forgotten they were ever initiated! And yet they belong to a class which aggregates over sixty per cent of the total membership, and with which the Society has never come into real affiliation. It seems the least that may be done is to provide as many of our alumni as possible with copies of the QUARTERLY, and further, that some arrangement be developed whereby each chapter comes into contact with, and develops a deeper realization of the value of its alumni membership. Unless some such measures be undertaken, the question may arise as to what benefit accrues to the Society, or to the individual concerned by virtue of this class of alumni membership.

Advantage is also taken of the opportunity at this time to mention another matter which has been suggested by one of the questions in the circular letter referred to above—namely, the extent to which social possibilities are emphasized in the chapters.

There is a very definite reason for the existence of Sigma Xi. Just as the Founders of the Society distinctly saw the necessity and desirability of its existence, so should the purpose at present ever be to proceed, insofar as this is possible, towards an ever growing realization of their ideals. By reference to the constitution, we find that one of the objects of Sigma Xi is to establish fraternal relations among those engaged in scientific research. Indeed the Founders appreciated the importance of the promotion of good-fellowship and a fraternal spirit, and for this reason, such an object should receive the united and unanimous support of the Society. The complete exemplification of the ideals and objects of Sigma Xi means more than the advancement of science by research—it also emphasizes that mutual development and pleasure which result

from social contact with other investigators. That the idea is not working out as satisfactorily as may be desired is the suspicion of many, and is also indicated to a greater or less degree by the nature of the chapter replies to the above question given in the article cited.

Most men who are devoting their life work to the development of science are doing thus because they so desire. They are exerting the best efforts in their particular specialties purely through a personal love of the work, or perhaps ambition. Thus the progress one may accomplish in a chosen field is encouraged not so much by any impetus he may receive from membership in a scientific society, as it is by his own individual attitude. To associate with such men, to acquire an appreciaton of their illuminating minds and work, in short to understand them, is indeed a privilege and it is this advantage which Sigma Xi may offer without limit. To those who make use of such opportunities, the rewards are beyond mention. There is also produced that desirable and broadening influence whereby the narrowness developed by excessive and intensive specialization is counteracted.

Theoretically no group of men is as free from prejudice and ready to admit the points of view of others as scientific investigators. Yet it is familiar to all how simple a matter it is, especially among the younger men, to believe that one's own field is the only one worthy of concentrated attention, one's own department the most important one in the institution. However, with the development of the true ideals of Sigma Xi, such an attitude will never entertain serious consideration.

Progress in all branches of scientific work resolves itself finally into the accomplishments of the individual worker, who is assumed to put all his energy into the task purely as a personal matter; nevertheless he is not supposed to let himself develop too narrowly. A scientist possesses primarily powers of individual thought, and as such is capable of broad and extensive development. Only too often are instances brought into evidence where the engineers, for example, dealing with science in its practical aspects are known to scoff at the investigators who are delving into the unknown domains of pure science. Coöperation and a practical solution of the problem such as Sigma Xi could afford, would do much to reconcile the general differences of opinion; and the acute and aggressive criticism, by one class of another, would become unknown.

As was mentioned previously, a thorough understanding and appreciation of the line of thought another is following, is conducive to a higher and more glorious sphere of usefulness. A glance at the leaders of our various realms of endeavors will fairly always yield the result that not least among the necessary qualifications is personality. In order to be able to influence others, to impress one's thoughts and ideas upon a greater and larger number of the community, just so much the more must the individual personality be important. If one have nothing in common with his associates, no matter how intensive his intellect, even though his light burn with the brilliancy of a thousand candle-power, it will be only as through a dense mist. To strive continually and only for the advancement of science may perhaps realize a noble ideal, but the individual as a human being will be sacrificed, and the fulfillment of a complete and full life will never be realized. No instructor for example, can present a message in the classroom unless he has a true appreciation of those whom he seeks to instruct. This true appreciation can be gathered only by personal contact.

Social intercourse seems to be a desirable asset in any professional life if one would reap the maximum benefits. To be sure, more emphasis may have been placed upon the above condition of circumstances than may be warranted by a true statement of the facts as they exist within the Society. However, when we realize that one of our chapters has no social activities whatsoever, and that in another, meetings are strictly departmental in character, it would appear perhaps that these two chapters are overlooking one of the essential objects for which Sigma Xi was founded.

THE CHICAGO CHAPTER

The Chicago Chapter held three regular quarterly meetings during the year 1914-15, and tried the policy of starting the evening's festivities in each case with a subsidized dinner at the Quadrangle Club. Since the idea of getting something for nothing seems to appeal as strongly to people of scientific attainments as to the non-scientific, this policy proved to be a distinct success. After dinner a short business meeting was held, at which the new members, previously elected by the electoral board, were initiated and such business as came before the chapter, transacted. This was followed by the formal address of the evening.

At the autumn Quarter meeting on December 5, 1914, Dr. Arthur Gordon Webster, of Clark University, spoke most fascinatingly upon

The Rôle of Chance in Scientific Discovery. The winter Quarter meeting was held on January 20, 1915, at which Professor Jagadis Chambra Bose, of Presidency College, Calcutta, India, gave a very humorous and instructive talk on Plant Autographs and their Revelations. At the spring Quarter meeting on June 1 the chapter elected the following officers for the years 1915-1917:

President, Professor C. J. Herrick.

Vice-President, Professor E. B. Frost.

Secretary-Treasurer, Professor Robert Retzer.

The four-year term of Dr. Julius Stieglitz, as Corresponding Secretary, does not expire till 1917. The chapter also chose an Electoral Board consisting of Professors R. A. Millikan, E. J. Wilczynski, W. D. Harkins, C. M. Child, and F. C. Koch. The address of the evening was given by Professor Thomas Chrowder Chamberlin of the University of Chicago, who spoke on The Birth of the Earth and its Inheritance.

During the year the following have been initiated into the Chapter:

GRADUATE STUDENTS

Carl B. Anderson, S.B., Nebraska, 1912; Fellow in Geology.

Research: Character of Artesian Well Water in Chicago; Underground Water Resources of Northeastern Illinois.

Ada Hart Arlitt, A.B., Tulane, 1913; Fellow in Psychology.

Research: Effect of Alcohol upon Intelligent Behavior of Animals.

Arthur C. Bevan, A.B., Ohio Wesleyan, 1913; Fellow in Geology.

Research: Geology of the New Lexington Quadrangle, Southeastern Ohio.

Denton J. Brown, A.B., Texas, 1910; A.M., Ibid., 1912; Assistant in Chemistry.

Research: Electroanalysis; Peroxide Decompositions.

Frank Emerson Brown, A.B., Kansas Normal College; S.B., Chicago, 1913.

Research: On Surface Tension between Two Liquids.

John William Campbell, A.B., Queen's University, Kingston, Canada, 1912; A.M., Ibid., 1913; Fellow in Astronomy.

Research: On the Stability of Periodic and Non-Periodic Orbits.

Francis Easton Carr, A.B., Oberlin, 1906; S.B., Washington, 1908; A.M., Oberlin, 1912.

Research: The Theory of Precession by Methods of Periodic Orbits.

Elizabeth Caroline Crosby, S.B., Adrian; S.M., Chicago; Fellow in Anatomy.

Research: Laboratory Outline in Neurology; On the Nervous System of the Alligator.

Arthur J. Dempster, A.B., Toronto, 1909; A.M., Ibid., 1910.

Research: On the Mobility of Ions in Air at High Pressure; Ueber die Theorie der Schwarzen Strahlung.

René De Poyen, S.B., Chicago, 1914; Assistant in Chemistry.

Research: The Constitution of Lactose.

Sarah Lucinde Doubt, S.B., Nebraska, 1903; S.M., Chicago, 1908.

Research: Gas Injury to Plants.

Alphaeus W. Dupler, A.B., Juniata College, 1911.

Research: The Morphology of Taxus Canadensis.

Clayton H. Eaton, A.B., Nebraska, 1913; Fellow in Paleontology.

Research: On Fossil Mammals.

Oscar Jacob Elsesser, S.B., Chicago, 1913; Research Assistant in Pathology.

Research: The Action of Immune Sera on Vegetable Proteins with particular reference to the Specificity of the Abderholden Reaction.

James Frederick Groves, S.B., Ewing College, 1906.

Research: Evaporation and Soil Moisture; A Method of Prophesying the Life Duration of Seeds.

Harry Ginsberg, S.B., Chicago, 1914; Assistant in Physiology.

Research: The Influence of Blood Transfusion on the Hyperglycemia of Pancreatic Diabetes; The Influence of Late Pregnancy on Pancreatic Diabetes.

Milton Theodore Hanke, S.B., Chicago, 1914; Assistant in Chemistry.

Research: The Constitution of Maltose.

Leo L. J. Hardt, S.B., Chicago, 1914; Assistant in Physiology.

Research: The Relation of the Gastric Digestion Contractions to the Hunger Contractions; Experimental Gastric Ulcers.

Jasper O. Hassler, A.B., William Jewell, 1907; S.M., Chicago, 1913.

Research: Projective Differential Geometry of the Cycloid; Theory of Plane Nets.

Herman Gusavus Heil, Ph.B., Chicago, 1905; Assistant in Physics.

Research: Energies of Impact Necessary to Produce Ionization in case of Sodium and Lithium Vapors.

Lawrence M. Henderson, S.B., St. Olaf's College, 1910; S.M., St. Olaf's College, 1911; Fellow in Chemistry.

Research: The Thorium-Mesothorium Ratio.

Henry L. Huber, Eastern Illinois Normal School, 1909; S.B., Chicago, 1913; Research Assistant in Pathology.

Research: On the Toxicology and Chemotherapy of Certain Copper Compounds.

Henry Reist Kraybill, S.B., Pennsylvania State, 1913; Fellow in Botany.

Research: Some Chemical Changes in the Resweating of Tobacco.

Towner R. Leigh, S.B., Iuka College, 1901; A.B., Lebanon, 1902; Fellow in Chemistry.

Research: On Chlorimides.

Millard S. Markle, S.B., Earlham, 1910.

Research: Development of Reproductive Organs in Coleochaete; Studies on the Vegetation of New Mexico.

Carl Richard Moore, S.B., Drury College, 1913; A.M., Ibid., 1914; Fellow in Zoölogy.

Research: Superposition of Fertilization on Parthenogenesis.

Raymond Cecil Moore, A.B., Dennison, 1913; Fellow in Geology.

Research: Study of Lance and Fort Union Stratigraphy and Paleontology, Western North Dakota and Eastern Montana; Glacial Geology and Stratigraphy, Mankato District, Minnesota.

Raymond D. Mullinix, S.B., Chicago, 1913; Associate in Chemistry.

Research: The Spontaneous Decomposition of Aluminate Solutions.

Mildred Nothnagel, A.B., Indiana, 1913.

Research: First Mitosis of Pollen Mother Cells of Allium cernuum, Roth; Monroe County Mosses, I, II, III.

Jeanette Brown Obenchain, Ph.B., Chicago; Research Assistant in Neurology.

Research: On the Brain of the Lamprey.

William Tudor Pearce, A.B., Randolph-Macon College, 1910; S.M., Kentucky 1912. Assistant in Chemistry.

Research: The Precipitation of Sulphuric Acid in the Presence of Thorium; The Solubility of Strontium Bromide in Strontium Nitrate; The Solubility of $K_4Fe(CN)_6$ in $Na_4Fe(CN)_6$.

Charles Frank Phipps, S.B., Wesleyan, 1906; S.M., Chicago, 1914; Instructor in Zoölogy, School of Education, University of Chicago.

Research: An Experimental Study of Amphipods with respect to Light Intensity, Direction of Rays and Metabolism.

Samuel Watson Reaves, S.B., North Carolina, 1899; A.B., Cornell, 1900; A.M., Chicago, 1912; Professor of Mathematics, University of Oklahoma.

Research: On the Projective Differential Geometry of Plane Anharmonic Curves; Theory of Ruled Surfaces.

Edith Adelaide Roberts, A.B., Smith, 1905; Instructor in Botany, Mt. Holyoke.

Research: Plant Succession of the Holyoke Range; Distribution of Beach Plants; On the Experimental Morphology of Root Hairs.

Willard Allen Roberts, S.B., Earlham, 1911.

Research: On the Structure of the Cobaltammines.

Fred T. Rogers, S.B., Baylor University, 1911; A.M., Ibid., 1914; Fellow in Physiology.

Research: The Gastric Hunger Contractions in the Rabbit.

Homer C. Sampson, S.B., Chicago, 1914.

Research: Methods in Atmometry; Studies in Physics of Soil Water; An Ecological Study of Prairies.

Oscar William Silvey, A.B., Indiana, 1907; A.M., Ibid., 1910; Instructor in Physics.

Research: An Investigation of a Point Discharge in Electric and Magnetic Fields.

Le Roy Hendrick Sloan, S.B., Chicago, 1914; Assistant in Physiology.

Research: Quantitative Estimation of the Protrolytic Enzymes in the Blood.

Pauline Sperry, A.B., Smith, 1906; A.M., Ibid., 1908; A.M., Chicago, 1914; Instructor in Mathematics Smith College.

Research: On the Theory of a one to two Correspondence with Geometrical Illustrations; On a Certain Class of Curves on Surfaces.

Thomas Russell Wilkins, A.B., McMaster, 1912.

Research: The Specific Heat of Tungsten at High Temperatures.

Kono Yasui, Tokyo College for Women.

Research: Life-history of Salvinici natans; Morphology of Azolla.

The active membership of the Chapter at the present time numbers 183. ROLLIN T. CHAMBERLIN, *Recording Secretary.*

THE MISSOURI CHAPTER

The chapters at the Universities of Kansas and Missouri unite each year to secure a series of two or three lectures at each institution. These annual lectures were delivered in November, 1914, by Professor Joseph Barrell of Yale University. The general title was, The Bearing of Geology on Man's Place in Nature.

Dean E. J. McCaustland of the School of Engineering addressed the Society in March, 1915, on Problems of Sewage Disposal.

Heretofore, the Society has dispensed with scientific meetings other than the open ones of spring and fall, because that function was performed by a general scientific association. With the decline of that somewhat unwieldy organization, the executive committee has recently outlined a policy of frequent addresses by members on the subjects of their investigations.

The following new members were initiated in May, 1915:

FACULTY

Oliver Ray Johnson, B.S. in Agr., A.M., University of Missouri, Assistant Professor of Farm Management. Distribution of Farm Labor; Land Tenure; The Relation of the Size of the Farm Business to Farm Profits: Research Bulletins, Agr. Exper. Sta.

GRADUATE STUDENTS

Everett E. Butler, A.B., '14, A.M. '15. Pathology. An Anatomical Analysis of the Effects of Ether Anesthesia on the Nerve Cell: Thesis for the Master's degree (ready for publication).

John M. Carter, A.B., '14, A.M., '15. Physiology. The Correlation between the Lipase and Fat Content of the Liver in Different Stages of Nutrition: Thesis for the Master's degree.

J. P. Connolly, A.B., Oberlin, '12, A.M., Missouri, '15. Geology. The Chouteau Limestone in Eastern Missouri: Thesis for the Master's degree.

Carl M. Greene, A.B., '14, Graduate Student, '15. Physiology. (With C. W. Greene) The Skeletal Musculature of the King Salmon: Bull. U. S. Bur. Fisheries, Vol. 33, pp. 19-60; The Irritability of Muscle under Variations of Temperature (ready for publication).

F. L. Hisaw, A.B., '14. Zoölogy. The Ecology of Aquatic Insects of Carter Creek, Colo. (in progress).

E. A. Martin, A.B., '14, Zoölogy. Development of the Fresh Water Mussel *Straphitus edentulus* (in progress).

C. E. Neff, B.S. in Agr., '14, A.M., '15. Farm Crops. Some Correlation Studies in Maize: Thesis for the Master's degree.

E. E. Nelson, A.B., Drury College, '14. Zoölogy. Studies in Cytology (in progress).

O. I. Oshel, B.S. in Agr., Kansas State Agriculture College, A.M., Missouri, '15. Research Scholar in Dairy Husbandry. Silage Investigations: Thesis for the Master's degree.

L. S. Riford, B.S., '14, New Hampshire State College A.M., Missouri '15. Research Scholar in Dairy Husbandry. A study of Protein Requirements for the Growth of Animals: Thesis for the Master's degree.

Julia Spalding, B.S. in Ed., '10, A.M., '15. Mathematics. On Certain Functions of a Complex Variable: Thesis for the Master's degree.

William S. Summers, A.B., '14, A.M., '15. Physiology. The Correlation between the Lipase and Fat Content of the Blood in Different Stages of Nutrition: Thesis for the Master's degree.

Thomas F. Wheeldon, A.B., '14, A.M., '15. Anatomy. The Heart of the 20mm. Pig Embryo: Thesis for the Master's degree (in press).

D. H. DOLLEY, *Secretary.*

THE SYRACUSE CHAPTER

During the academic year 1914-15, the Syracuse Chapter has held nine meetings. Five of these were open meetings at which lectures were given, two by our own members, and three by distinguished members of other chapters. The interest shown in these open meetings by both students and townspeople, was very gratifying.

The list of meetings and of speakers follows:

October 2: Report by F. A. Harvey on the Rutherford lectures before the National Academy of Science; Report by E. D. Roe, Jr., on the meeting of the American Mathematical Society at Brown.

November 6: Research reports by members as follows: E. C. Day, Electric Currents Generated in the Eye by Light, and L. H. Pennington, Studies of Forest Fungi.

November 10: Open meeting, lecture by F. P. Knowlton, M.D., Director of the Physiological Laboratory, Syracuse University, Hunger and Allied Phenomena.

November 17: Open meeting, lecture by H. A. Peck, Ph.D. Professor of Astronomy, Syracuse University, Recent Theories of the Siderial Universe.

December 15: Open meeting, lecture by G. N. Stewart, M.D., Professor of Experimental Medicine, Western Reserve Medical School, The Physiologist in the Hospital and in the State.

February 5: Open meeting, lecture by John A. Mathews, Operating Manager of the Halcomb Steel Co., Iron in Antiquity and Today.

March 5: Open meeting, lecture by H. S. White, Ph.D., Professor of Mathematics, Vassar, Mathematics in the Science of the Nineteenth Century.

April 9: Research Reports from new members; titles given in the list of elections.

May 7: Annual reports of officers and annual election of officers.

The following were received into the chapter during the year:

FACULTY

Oliver W. H. Mitchell, Director of the Bacteriological Laboratory, affiliated from the Missouri Chapter.

Harry Philip Brown, Assistant Professor of Forest Botany, affiliated from the Cornell Chapter.

Loren Clifford Petry, Instructor in Botany, affiliated from the Chicago Chapter.

Robert Richard Tatnall, Professor of Physics, affiliated from the Northwestern Chapter.

Charles Christopher Adams, Assistant Professor of Forest Zoölogy, affiliated from the Illinois Chapter.

Ralph Rayburn Simmons, Instructor in Bacteriology, affiliated from the Missouri Chapter.

Louis Max Hickernell, Instructor in Zoölogy; Research, Desiccation of some Invertebrate Animals.

Charles Ruglas Hoover, Assistant Professor of Chemsitry; Research, Atomic Weight Determinations.

Henry Neely Jones, Assistant Professor of Bacteriology; Research, The Bovine Bacillus Abortus.

James Fred Baker, Director of Forest Investigations; Research, numerous investigations in National Forest Reserves.

GRADUATE STUDENTS

Abraham Clement Silverman, Graduate Student in Physiology; Research, Gaseous Metabolism in the Kidneys.

H. A. CLARK, *Secretary*.

MEMBERSHIP OF SIGMA XI

STATISTICS FOR 1914

Chapters			Elected in 1914				Total Elections Classified					Totals for 1914	
Number	Name	Totals for 1913	Undergraduates	Grad'te Students	Faculty Members	Alumni Members	Charter Members	Undergraduates	Grad'te Students	Faculty Members	Alumni Members	Grand Totals	Active membership
1	Cornell *	1196	20	31	3	8	13	568	475	142	60	1258	155
2	Rensselaer												
3	Union	188	8	2			15	31	103	42	7	198	21
4	Kansas	353	4		3	1	5	221	41	63	31	361	62
5	Yale	683	35	14			20	414	205	91	2	732	175
6	Minnesota	470		18	8		25	294	82	95		496	122
7	Nebraska	332	4	17			13	107	182	43	8	353	64
8	Ohio State	379	14	19	4	24	28	209	73	71	59	440	418
9	Pennsylvania	491	20	4	5		12	310	72	100	26	520	122
10	Brown	220	9	1			27	104	46	34	19	230	39
11	Iowa	222	14	6	1		12	120	69	42		243	53
12	Stanford	229	4	20	3		14	23	126	53	40	256	57
13	California	473	26	19	2		16	190	199	106	9	520	110
14	Columbia	450	18	11	21		22	187	204	54	33	500	117
15	Chicago	507		43			62	4	447	32	5	550	175
16	Michigan	563	18	18	7		36	369	107	91	3	606	140
17	Illinois	573	14	19	6		39	297	126	146	4	612	182
18	Case		20		1		17	110		53	44		28
19	Indiana	118		8	1		14	16	63	29	5	127	40
20	Missouri	205		13	1		23	88	53	54	1	219	81
21	Colorado	107	4	5	6		14	30	30	48		122	32
22	Northwestern	104	2	5	3	75	27	32	30	22	78	189	43
23	Syracuse *	117		1	9		16		48	55	5	127	48
24	Wisconsin	228		22	8		42		63	129	24	258	133
25	Univ. of Washington	93	16	3	3	1	27	48	15	24	2	116	43
26	Worcester	120	17	2	1	3	18	100	7	15	3	143	34
27	Purdue	104	8		2		21	55		38		114	64
28	Washington, St. L.	85	7	4	1	1	12	39	16	23	8	98	47
29	Dist. of Columbia						171					171	171
30	Texas						21		5	6		32	32

The totals for 1913 in the table are taken from the statistical table of last year (QUARTERLY, vol. I, p. 55) when not otherwise indicated. The elections for 1914 are copied from reports of Chapter secretaries for 1914 to last year's totals. All members are grouped on the basis of original membership, i. e., a member elected as a graduate student remains in that group although he may subsequently enter the faculty.

*Figures starred have been revised by chapter secretaries and all errors in classification of members corrected as well as omissions from the original lists made good. Names omitted from these lists are printed on page 35 of this number as reported by chapter secretaries.

The two defunct chapters enrolled 18 members not included in the totals as given in the table above.

In summing up the grand total of membership from all chapters, this method of reporting will produce an error, as many men will be counted twice, active in one chapter and alumni in another. But the local secretary sees no method of avoiding that with the above form.

CHAPTER OFFICERS

LIST FURNISHED BY THE CORRESPONDING SECRETARIES OF THE CHAPTERS

CHAPTER	PRESIDENT	VICE-PRESIDENT	REC. SECRETARY	COR. SECRETARY	TREASURER
Cornell	J. G. Needham	F. K. Richtmyer	J. G. Pertsch, Jr.	James McMahon	O. C. Johannsen
Rensselaer	E. N. D. Schulte	F. R. I. Sweeney	C. H. Andros	E. F. Chillman	E. F. Chillman
Union	Howard Opdyke	C. F. F. Garris	Morland King	Warren C. Taylor	Morland King
Kansas	H. P. Cady	W. C. Stevens	P. V. Faragher	W. J. Baumgartner	W. H. Twenhofel
Yale	L. L. Woodruff	H. L. Steward	T. A. Hatch	J. W. Roe	R H. Suttie
Minnesota	C. M. Jackson	C. W. Howard	H. Downey	G. Dietrichson	R. A. Hall
Nebraska	Samuel Avery	G. A. Loveland	V. L. Hollister	A. L. Candy	L. B. Tuckerman, Jr
Ohio	William C. Mills	A. W. Smith	A. E. Flowers	A. E. Flowers	T. E. French
Pennsylvania	E. C. Kirk	W. P. Laird	T. P. McCutcheon, Jr.	W. H. F. Addison	J. P. Moore
Brown	H. E. Walter	H. E. Walter	R. G. D. Richardson	Harlan H. York	C. H. Currier
Iowa	R. B. Wylie	J. N. Pearce	A. C. Trowbridge	G. L. Houser	R. P. Baker
Stanford	L. L. Burlingame	W. K. Fisher	J. O. Snyder	J. O. Snyder	J. O. Snyder
California	F. P. Gay	C. B. Lipman	R. S. Holway	Edmond O'Neill	A. C. Alvarez
Columbia	G. B. Pegram	J. K. Finch	W. W. Stifler	Wm. Campbell	W. W. Stifler
Chicago	C. J. Herrick	E. B. Frost	Robt. Retzer	J. Stieglitz	Robt. Retzer
Michigan	E. C. Case	A. M. Barrett	H. A. Gleason	H. A. Gleason	H. H. Higbie
Illinois	C. R. Richards	H. A. Harding	M. L. Enger	H. F. Moore	W. E. Joseph
Case	C. H. Fulton	F. H. Vase	W. R. Veazey	W. R. Veazey	C. D. Hodgman
Indiana	F. M. Andrews	Wm. Scott	M. E. Hufford	M. E. Hufford	W. M. Tucker
Missouri	M. F. Miller	E. R. Clark	D. H. Dolley	D. H. Dolley	C. B. Hutchison
Colorado	O. C. Lester	C. E. Giffin	P. G. Worcester	P. G. Worcester	Ira M. DeLong
Northwestern	W. L. Lewis	F. R. Zeit	E. J. Moulton	W. L. Woodburn	S. I. Kornhauser
Syracuse	R. A. Porter	F. P. Knowlton	R. D. Whitney	H. A. Clark	F. F. Decker
Wisconsin	C. E. Allen	L. J. Cole	Walter J. Meek	Walter J. Meek	M. O. Withey
Washington State	E. O. Eastwood	G. B. Rigg	R. E. Rose	Effie I. Riatt	G. S. Wilson
Worcester	F. Bonnet, Jr.	H. C. Ives	C. A. Pierce	R. K. Morley	C. A. Read
Purdue	A. M. Kenyon	R. G. Dukes	R. B. Wiley	R. L. Sackett	A. T. Wiancko
Washington Univ.	P. A. Shaffer	C. A. Waldo	E. O. Sweetser	J. M. Greenman	L. F. Nickell
Dist. of Columbia	Marcus Benjamin	I. K. Phelps	M. W. Lyon, Jr.	M. W Lyon, Jr.	D. R. Harper
Texas	J. T. Patterson	F. W. Simonds	E. L. Dodd	I. M. Lewis	S. L. Brown

Including Chatper Reports received up to December 1, 1915.

OFFICIAL ANNOUNCEMENTS

QUARTER CENTURY RECORD AND HISTORY

According to the instructions given by the General Convention, a copy will be sent prepaid on receipt of $2.50.

SIGMA XI QUARTERLY

Title Page and Table of Contents for Volume I or Volume II will be sent members or subscribers on request. A few extra copies of these volumes are to be had at the regular subscription price. Odd numbers will be sent members to fill gaps as long as the supply holds out.

PRINTED BLANKS

The General Convention has instructed the Secretary to keep for chapters a supply of printed blanks as enumerated below. According to instructions these are to be forwarded to chapters under the following stipulations:

Membership Certificates, stamped with the great seal of the Society. In packages of fifty prepaid, on advance payment of $2.50 for each package.

Index Cards, on the condition that a duplicate set be sent for the general index of the Society maintained in the secretary's office. Gratis on demand.

Report Blanks, for submitting annual reports giving chapter officers, elections, and other statistical data. Gratis on demand.

SIGMA XI PUBLICATIONS

It has been proposed to bind up a number of sets of important early documents regarding Sigma Xi and to place a set in each of a selected series of the leading libraries of this country.

The undersigned will be glad to receive copies of such publications relating to the Society in general or to any one of its chapters which those interested may be able and willing to furnish for this purpose.

There are now ten imperfect sets on hand; can you aid in completing them or in making others?

HENRY B. WARD